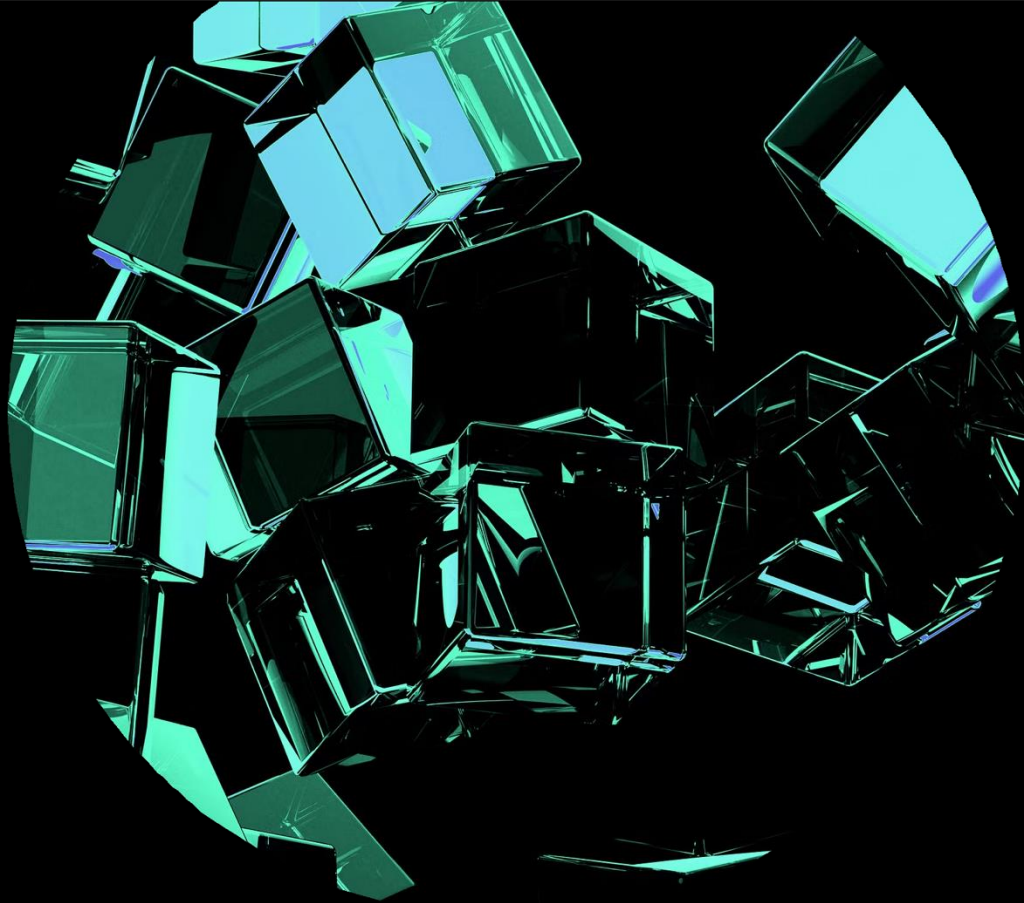


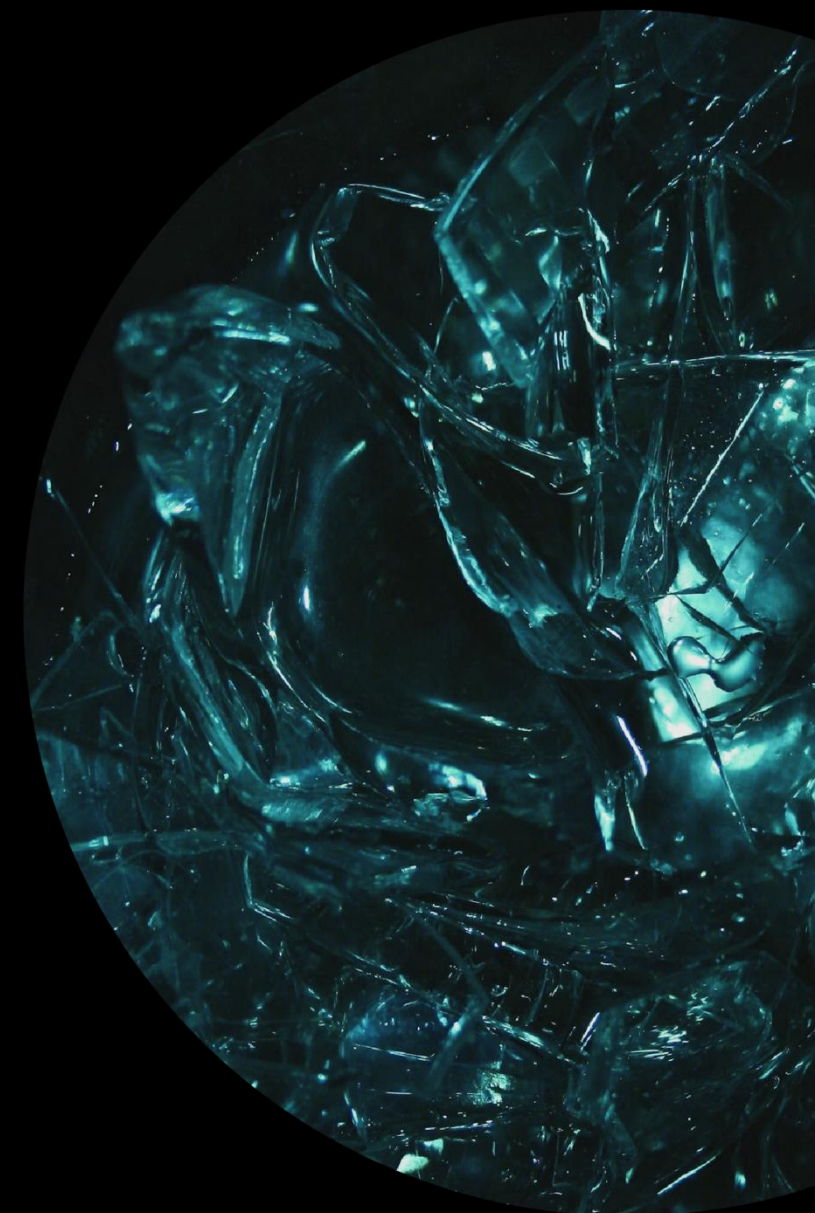


BioOrbit

Drug Production in Space: What are the benefits and the reality?

The Microgravity Opportunity – from Lab to In-Space Production

molly@bioorbit.com



SERAPHIM
SPACE ACCELERATOR

AIRBUS

UK SPACE
AGENCY
ACCELERATOR

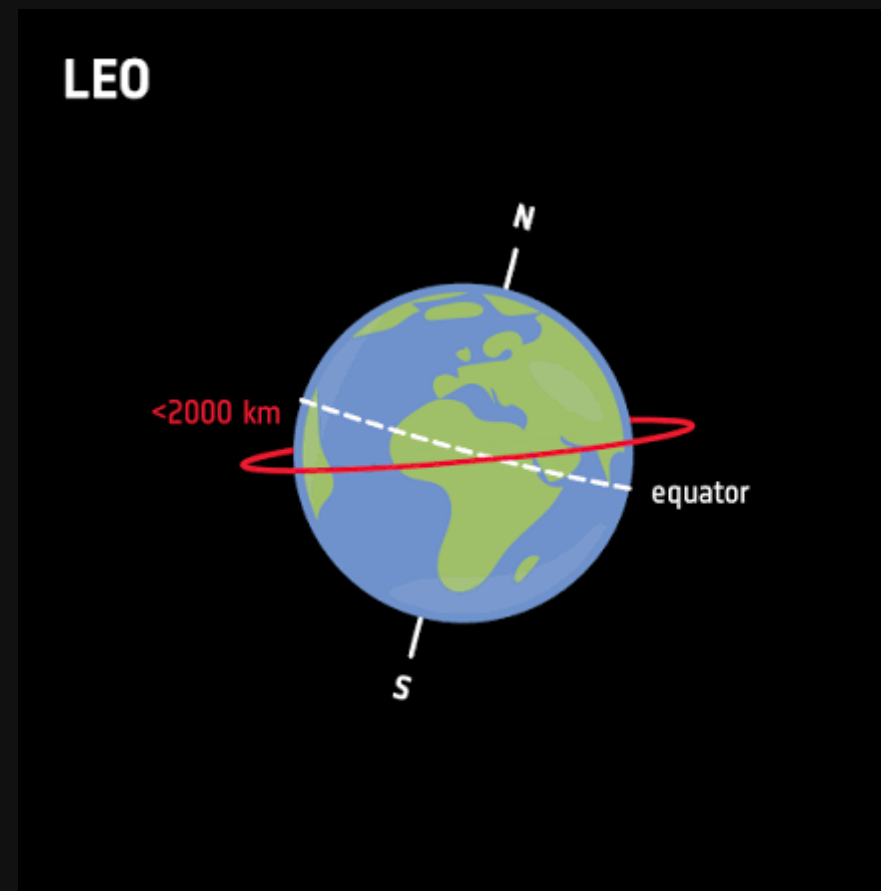


BUSINESS
INCUBATION
CENTRE

United
Kingdom

WHAT IS LOW EARTH ORBIT (LEO)

JUST LOOK UP



- LEO is an orbital region spanning from 160 to 2,000 km above Earth
- It is where the International Space Station (ISS) and most artificial satellites reside above our heads
- By comparison to the moon, it is close to Earth, therefore LEO requires the lowest launch energy while providing high-speed, low-latency communication

REASONS TO GO TO LOW EARTH ORBIT (LEO)

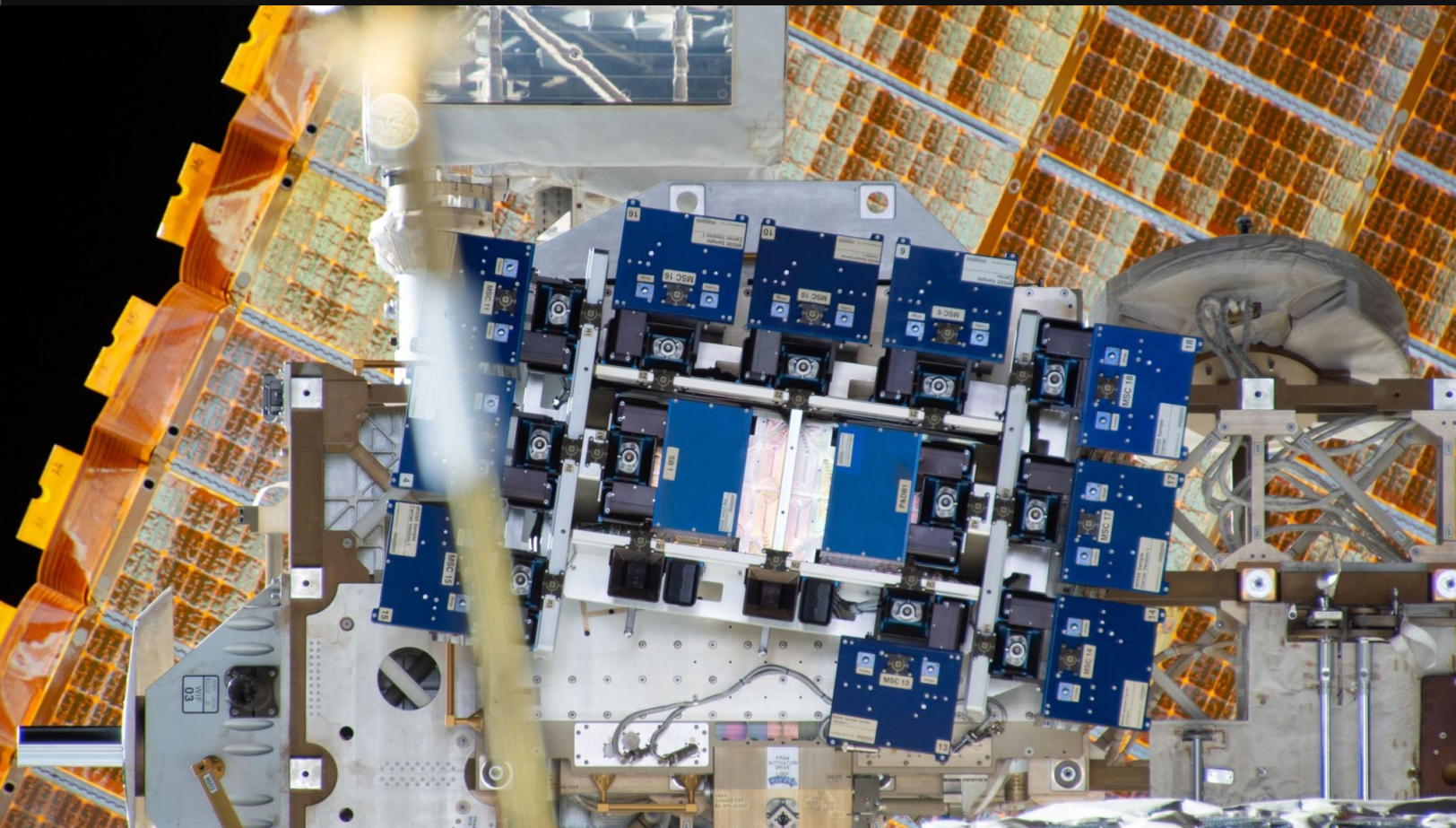
VANTAGE POINT



- 400 km above our heads
- Orbits the Earth every 90 minutes
- Covers 80% of the populated areas of Earth every 3 days
- Most unique vantage point for observing weather, land and sea mass, performing technology demonstrations and much more!

REASONS TO GO TO LOW EARTH ORBIT (LEO)

EXTREME CONDITIONS



- Temperatures swings from 120°C to -150°C because the ISS is either in direct sunlight or Earth's shadow
- A near-perfect vacuum
- Intense solar radiation
- Corrosive atomic oxygen



REASONS TO GO TO LOW EARTH ORBIT (LEO)

MICROGRAVITY



- Continuous Free Fall
- Orbiting the Earth every 90 minutes
- ISS travels at 28,000 km/h to not fall to the Earth's surface



EXPERIMENTATION IN THE MICROGRAVITY ENVIRONMENT **ON THE ISS**



No sedimentation

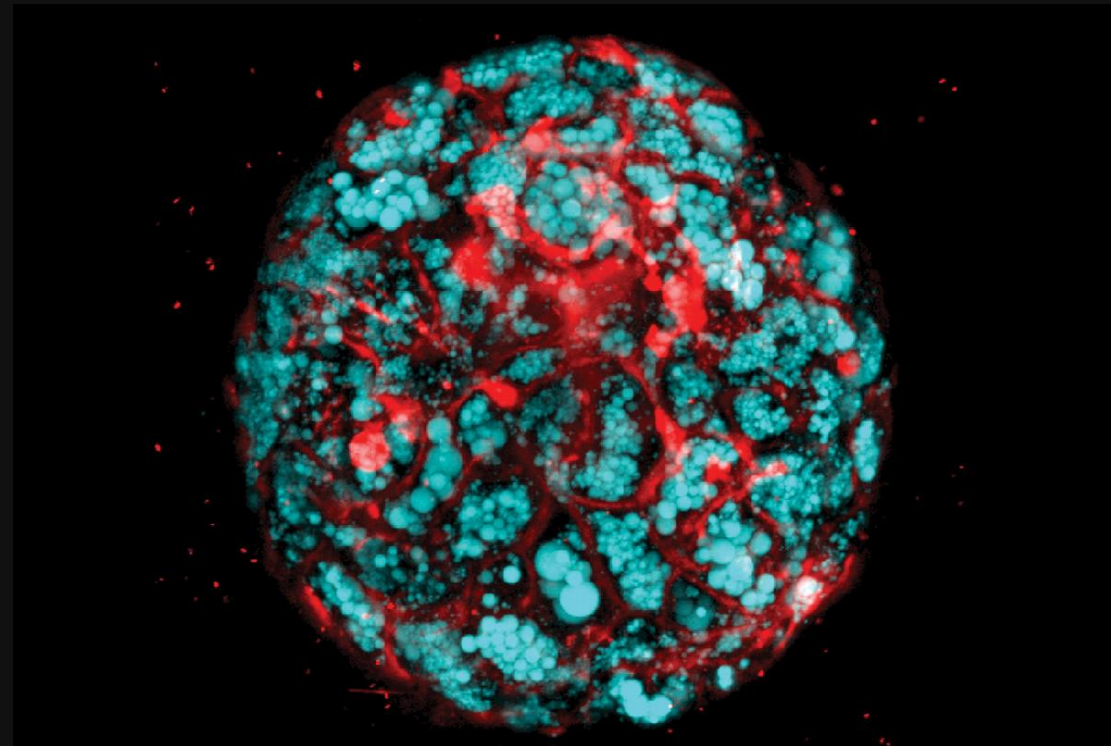
No convection currents

Self-assembly changes

Changes in gene expression

Plants grow different

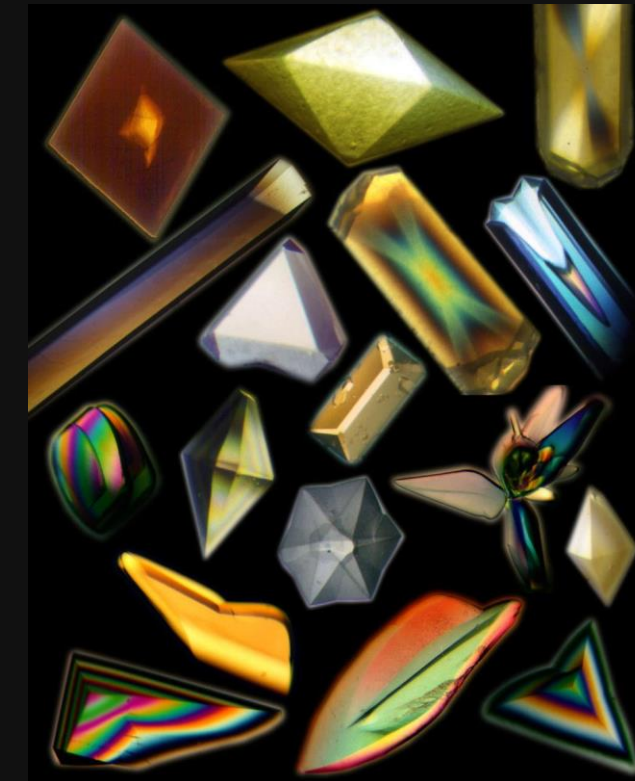
WITHOUT GRAVITY



Superior 3D structures

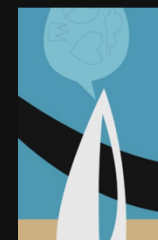
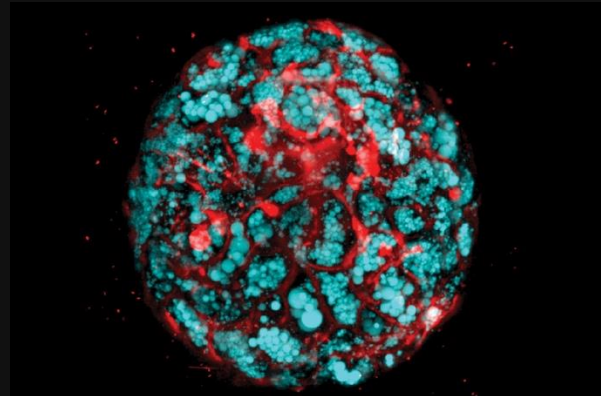


Physiological effects
mimic Earth diseases



Superior Crystallisation

SUCCESS STORIES



Aspera
Biomedicines

AMGEN[®]

Lilly

Anti-ADAR1

ADAR1 inhibitors slowed leukemia organoid growth.
Anti-ADAR1 drugs are in preclinical trials.

Osteoporosis

2 FDA-approved mAbs used to block bone growth inhibitors.

USE CASE OF CRYSTALLISATION

STRUCTURAL DETERMINATION



Mutant KRAS proteins
Developed drugs to prevent cancer growth by 'locking' KRAS proteins



Proteins associated with Muscle Dystrophy
Designed a drug now in Phase III

USE CASES OF CRYSTALLISATION

ULTRA HIGH CONCENTRATION

DRUG FORMULATION



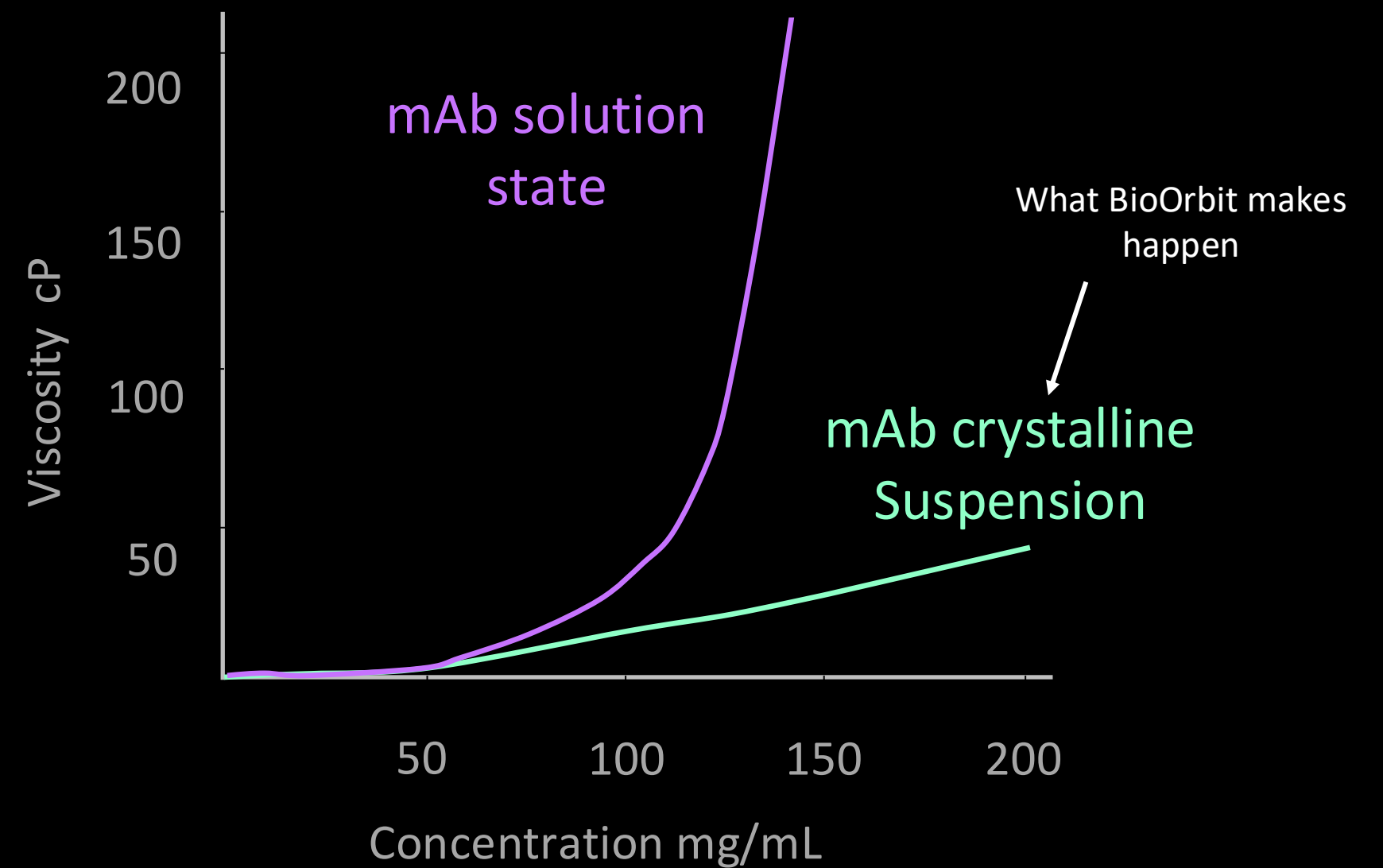
IN HOSPITAL



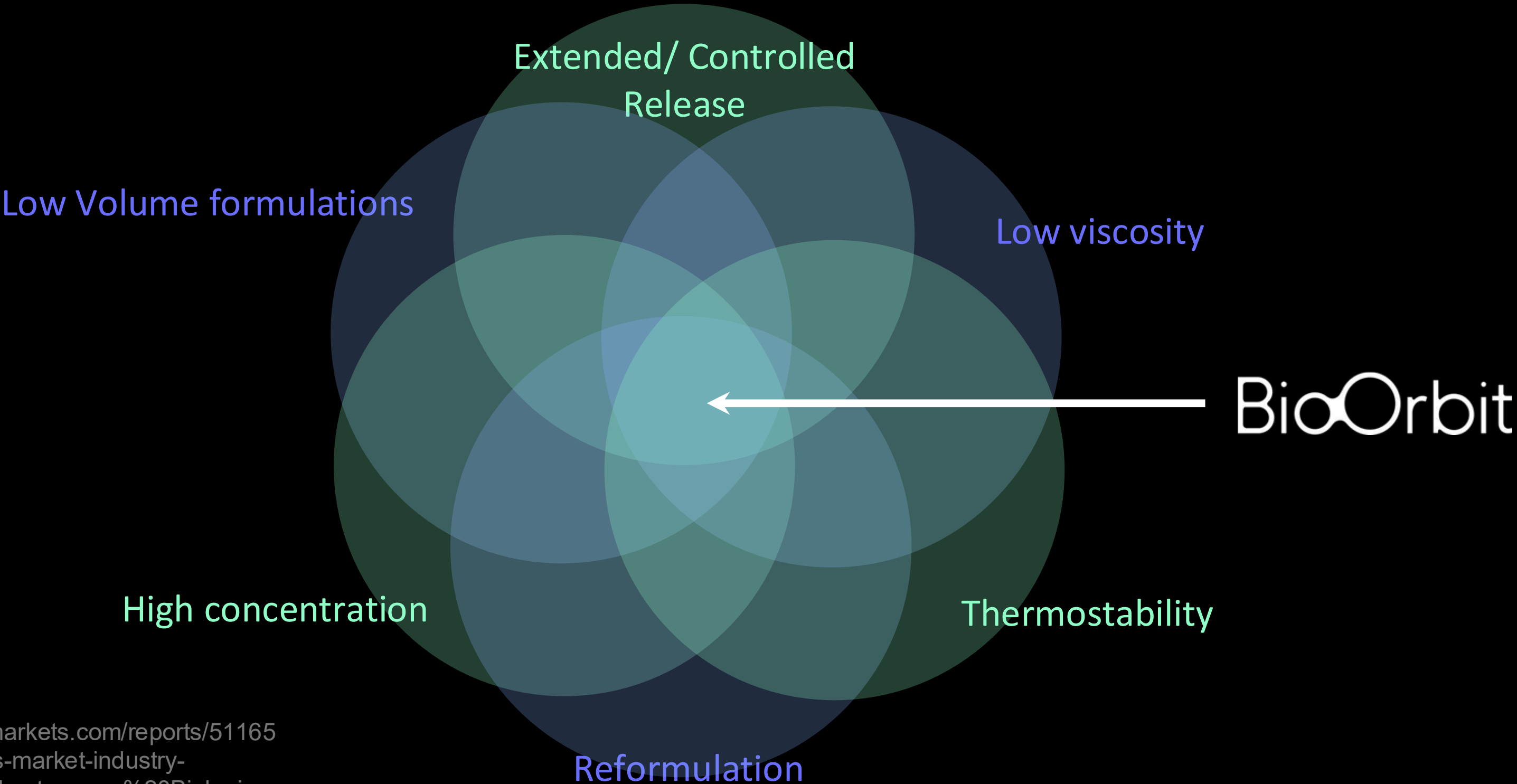
AT HOME / G P



If the viscosity is too high, the drug won't go through the injector



ONLY CRYSTALS ADDRESSES ALL OF THE KEY CHARACTERISTICS OF AN AT-HOME TREATMENT



<https://www.researchandmarkets.com/reports/5116514/subcutaneous-biologics-market-industry-trends#:~:text=The%20Subcutaneous%20Biologics%20Market%20for,growth%20during%20the%20for,ecast%20period.>

The benefits of microgravity have been demonstrated in Space



Pivotal Merck (MSD) paper studying Keytruda crystallization in Space

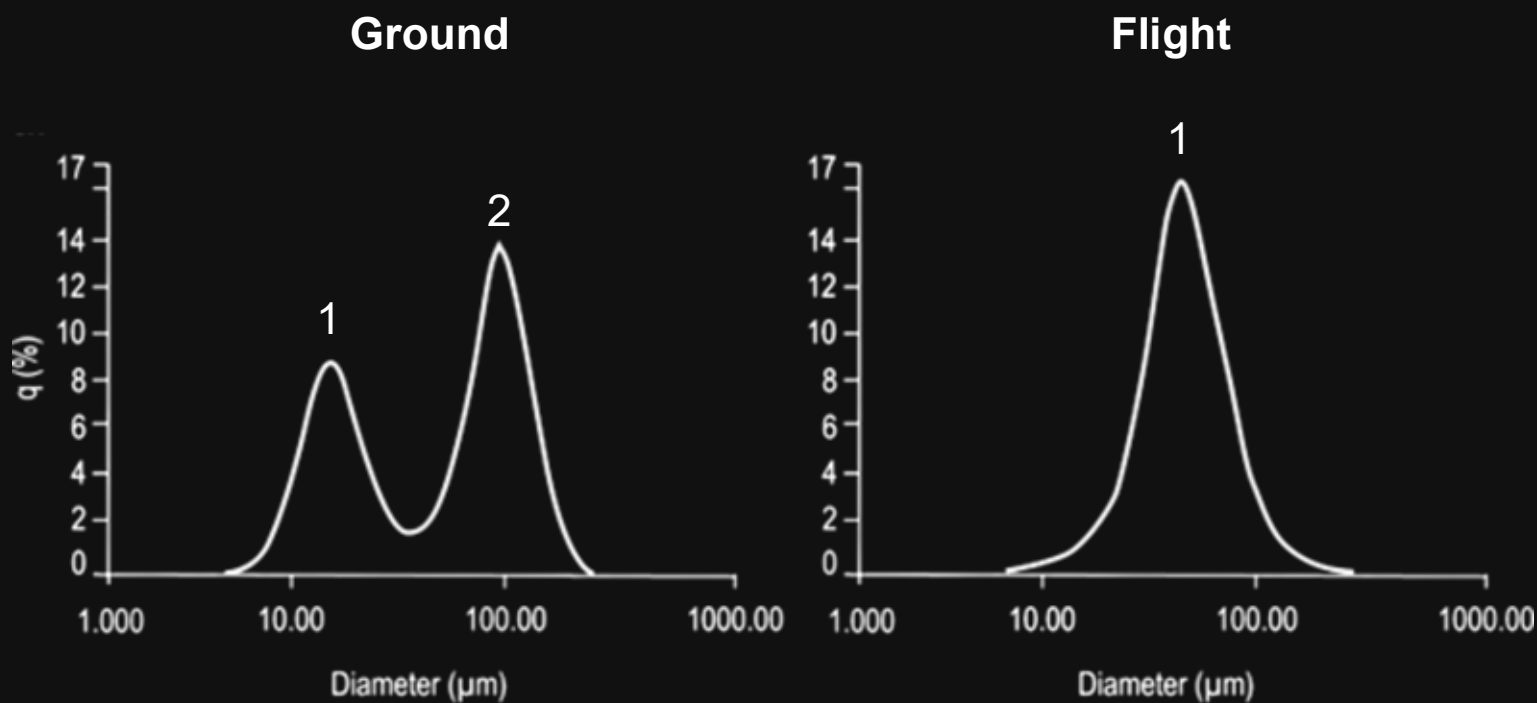
Pembrolizumab microgravity crystallization experimentation

npj Microgravity 5, 28 (2019)

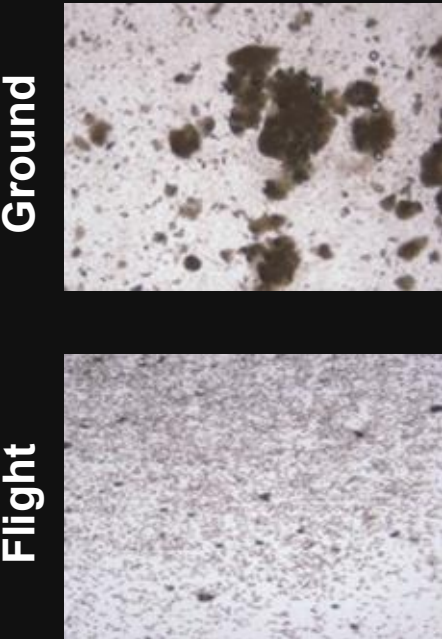
npj | microgravity



- Merck studied crystallization of Keytruda (PD-1 inhibitor) mAb on the ground and in flight
- They found improved size distribution in Space
- Potency in the ground and flown products was the same
- Findings were published in Nature Microgravity



Particle size analysis of ground-grown vs. in-flight-grown crystals



SONICC analysis (visual) of ground-grown vs. in-flight-grown crystals

Merck have taken a lead in exploring the manufacturing potential of space-based crystallization for reformulation



DRUG DEVELOPMENT

Pharma goes to space

Researchers are capitalizing on microgravity in space to accelerate drug discovery and development

by **Shi En Kim**

November 13, 2022 | A version of this story appeared in **Volume 100, Issue 40**

[Share](#)



 Menu

Innovation

Proteins in space: taking our research to the final frontier

Merck Research Laboratories scientist Paul Reichert works with the International Space Station to drive innovation

June 29, 2022

Share this article





News & Perspectives

Above and beyond: Our research returns to space

A team of Bristol Myers Squibb scientists is once again sending experiments into space, where microgravity conditions better support protein crystallization. The tiny crystals they're looking for could mean big things for patients.

Bloomberg

Subscribe

Business

Redwire to Develop Space-Based Drug Development and Manufacturing Platform

28 July 2022, 12:00 BST

Share this article



Redwire to Develop Space-Based Drug Development and Manufacturing Platform

Eli Lilly and Company is first investigator using new platform

Business Wire

MARKET OPPORTUNITIES

mAbs Therapy	2024	218 bn	Projected 2030	450 bn
Stem Cell Therapy	2024	17 bn	Projected 2030	42 bn
Bioreactors	2024	20 bn	Projected 2030	36 bn
Gene Therapy	2024	11 bn	Projected 2030	35 bn
Amyloidosis & Alzheimer's Therapy	2024	6 bn	Projected 2030	17 bn
Spheroid & Organoid development	2024	5 bn	Projected 2030	13 bn
3D Bioprinting	2024	4 bn	Projected 2030	10 bn

PRODUCTION IN SPACE

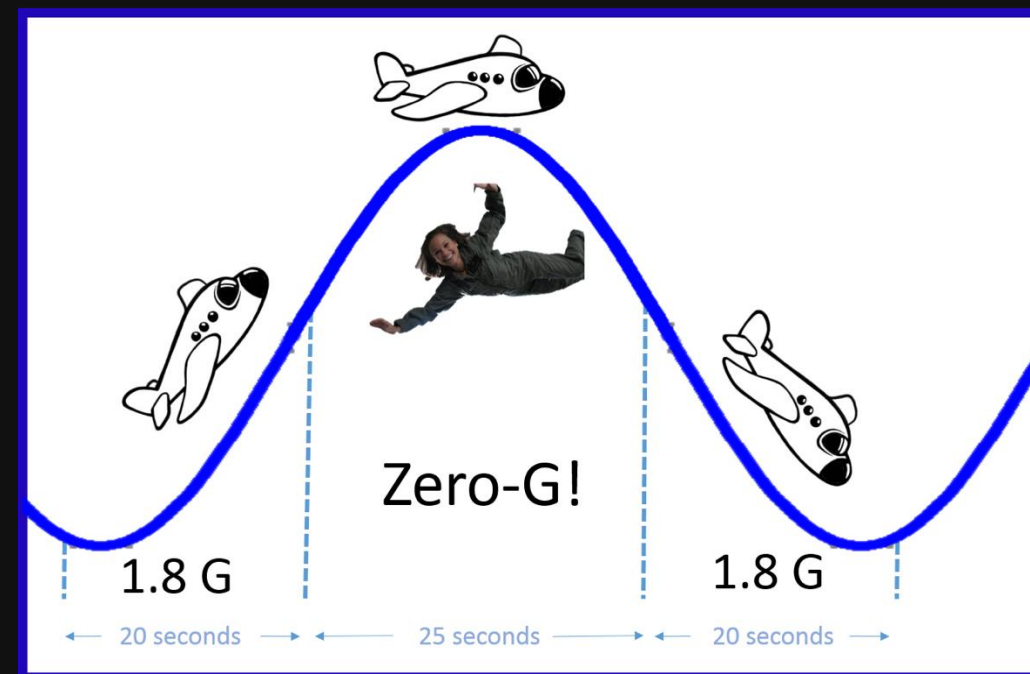
WHY CAN'T WE DO THIS ON EARTH?

Drop Towers



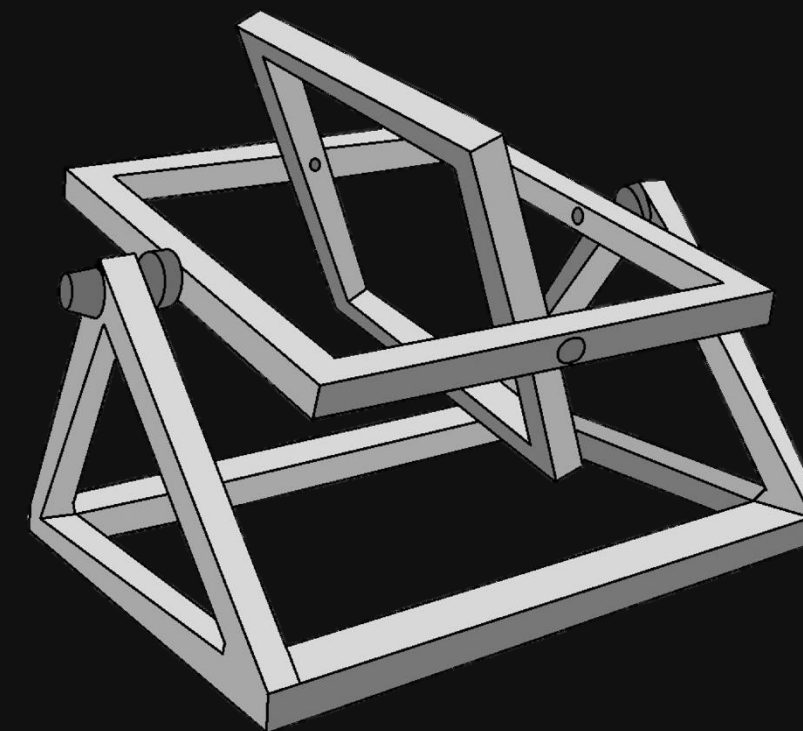
~10 seconds

Parabolic Flights



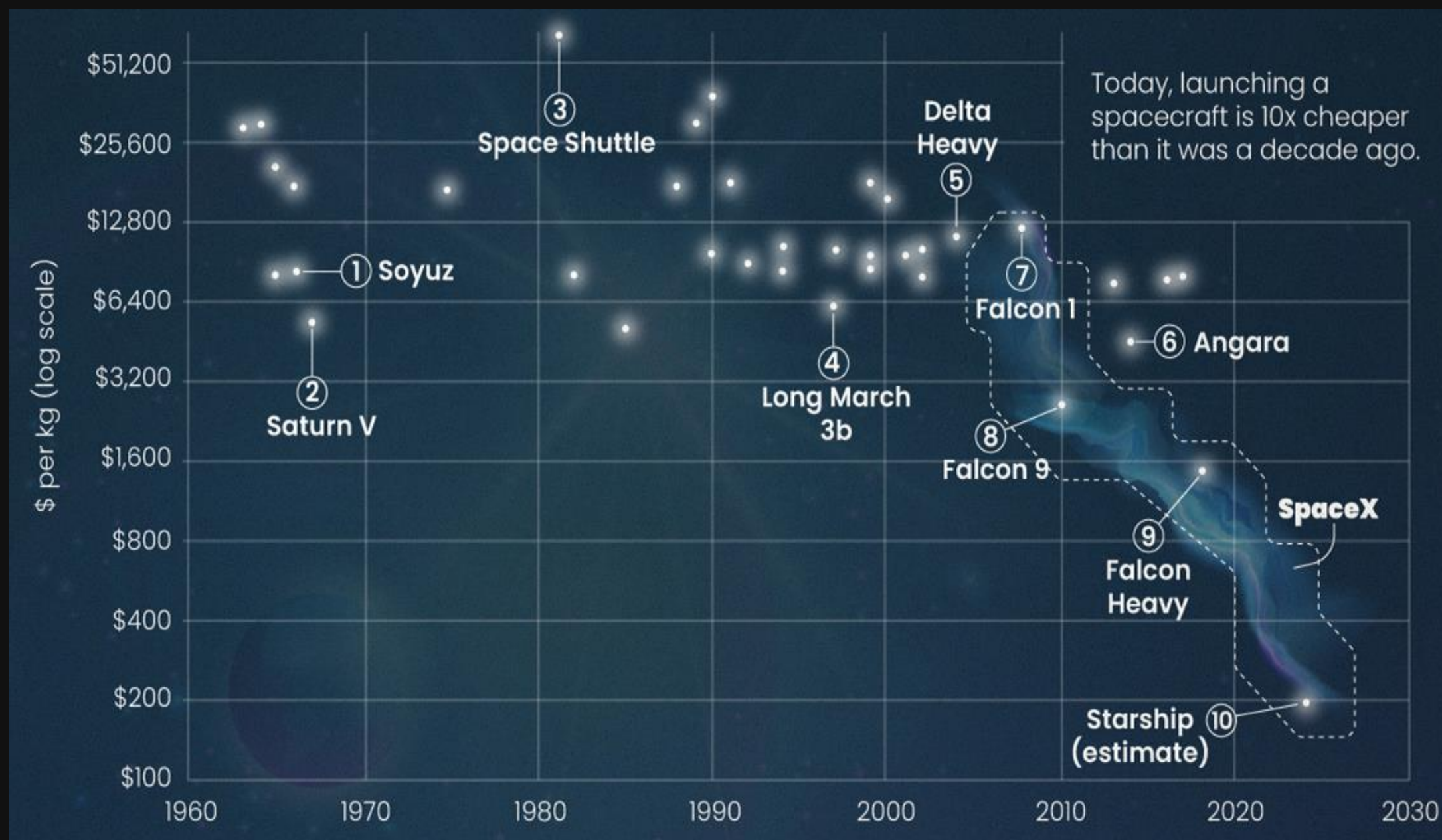
~30 seconds

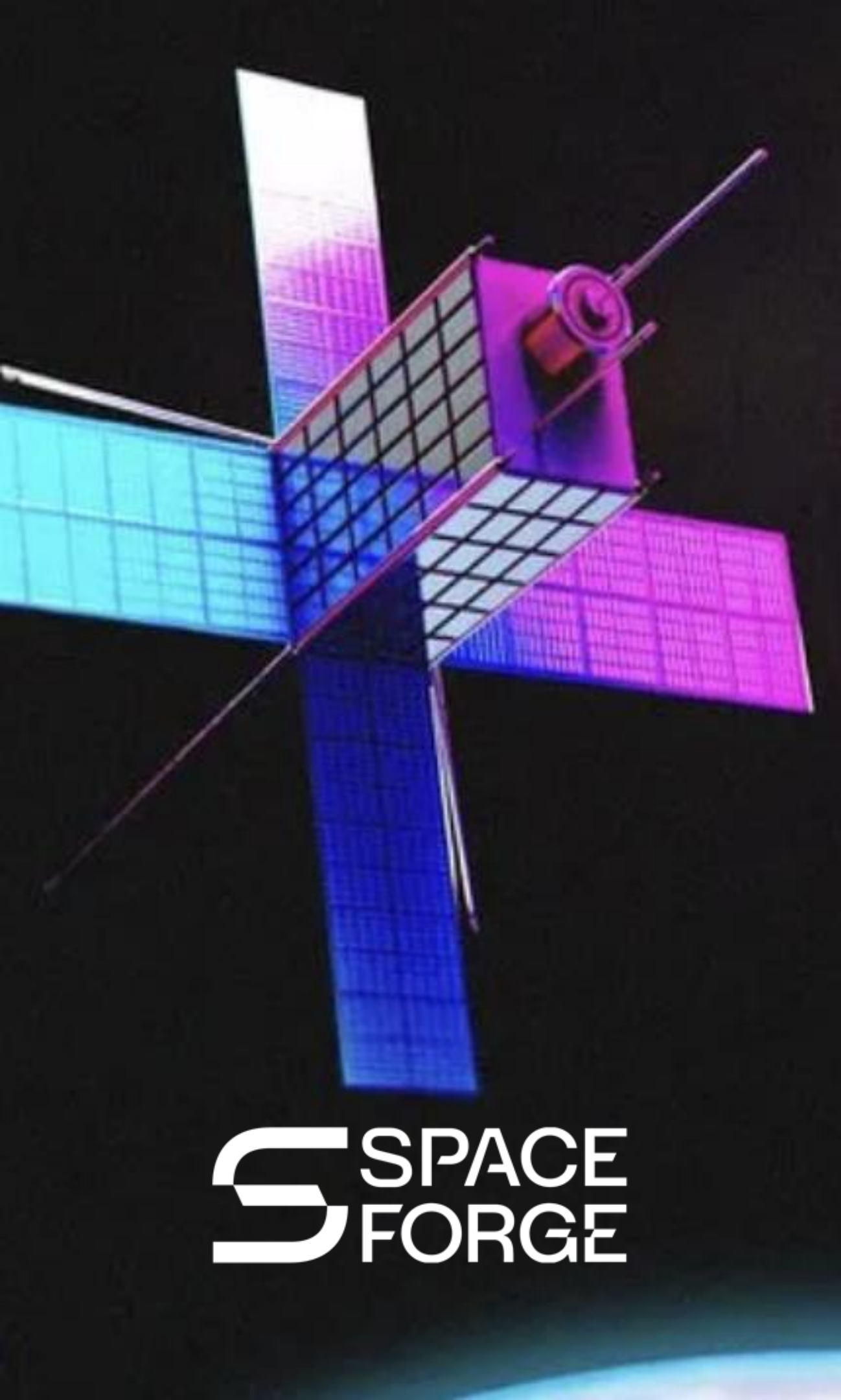
Random Positioning Machine



PRODUCTION IN SPACE

HOW DO WE BRING IT BACK?





**SPACE
FORGE**

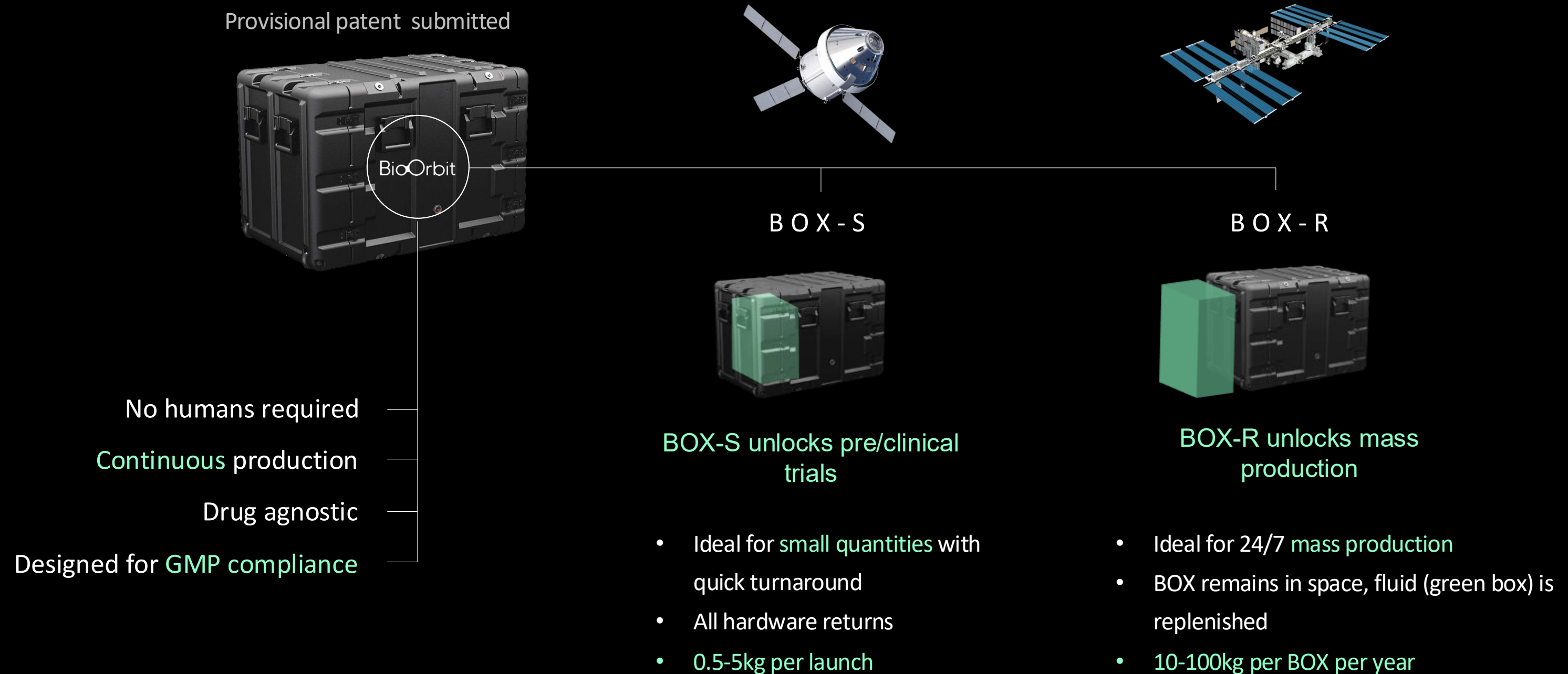


**The
Exploration
Company**



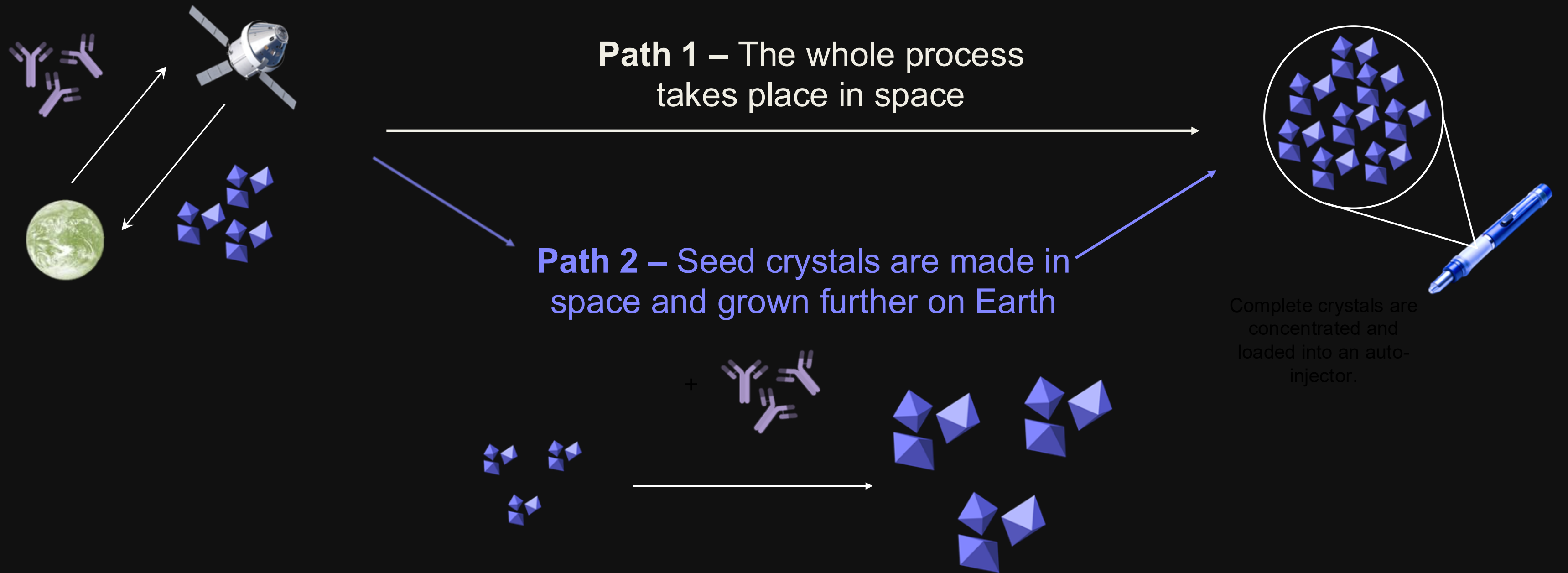
ATMOS

PRODUCTION IN SPACE HOW COULD THIS SCALE?



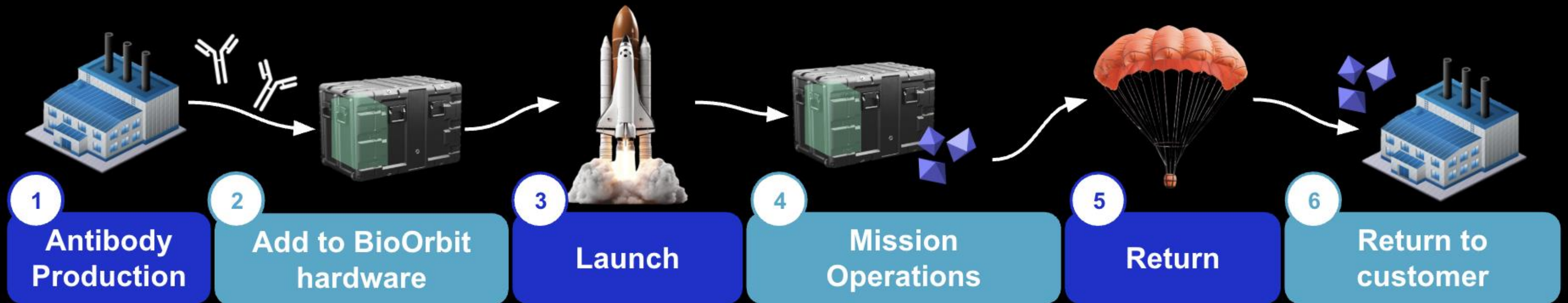
PRODUCTION IN SPACE

DO WE HAVE TO DO IT ALL IN SPACE?



PRODUCTION IN SPACE

WHAT DO OPERATIONS LOOK LIKE?



WHERE ARE YOU AT?

2026

2027

2028



BABY BOX-E

ISS

JUN 2026

Validate continuous
production in LEO with a
simple protein drug

*Payload flown on SpaceX-34
May 2026 and returned June
2026*



DRUG CRYSTALLISATION

2026-2027

Optimise crystallisation conditions of
a target drug with a pharma partner



BABY BOX-E 2.0

VAST & ISS

Demonstrate continuous
production of a mAb in
microgravity and safe return for
a second time



BOX-T

ISS & VAST

Demonstrate screening
of molecules for internal
development and partner
development



CO-DEVELOPMENT

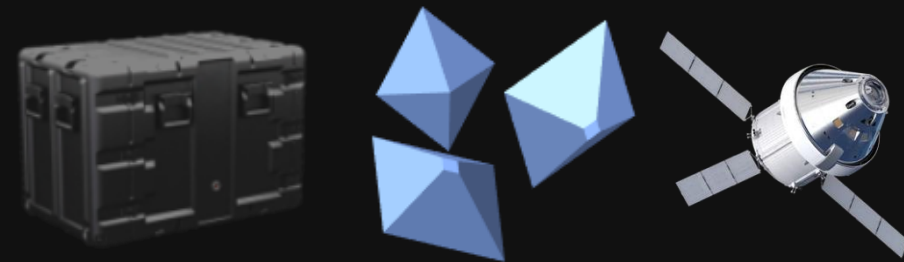
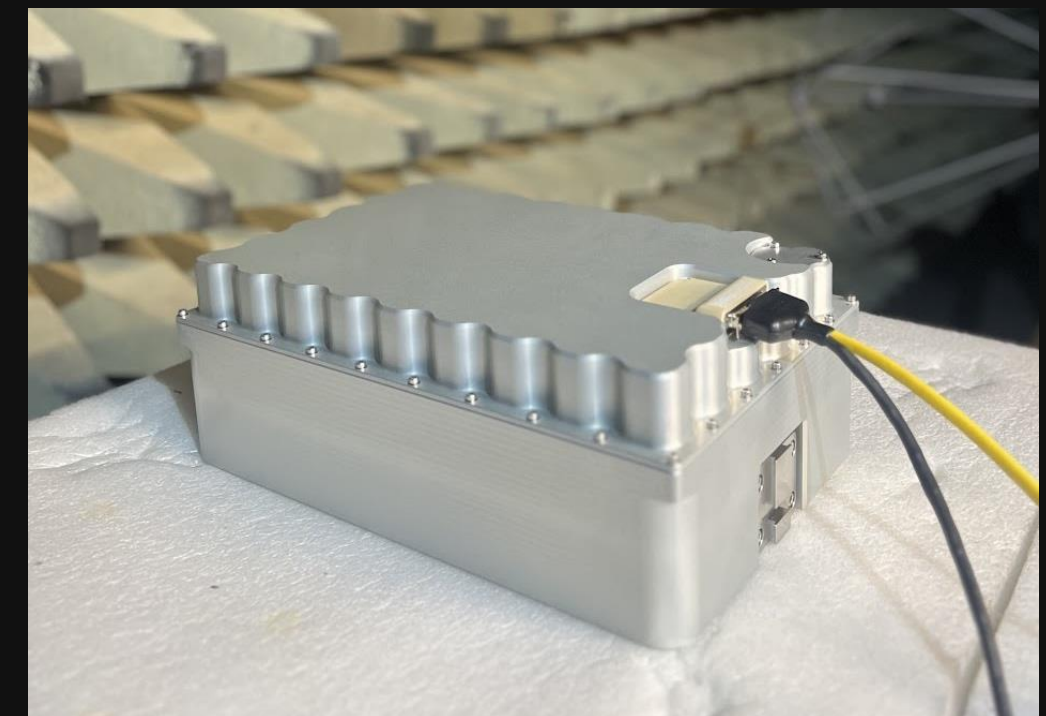
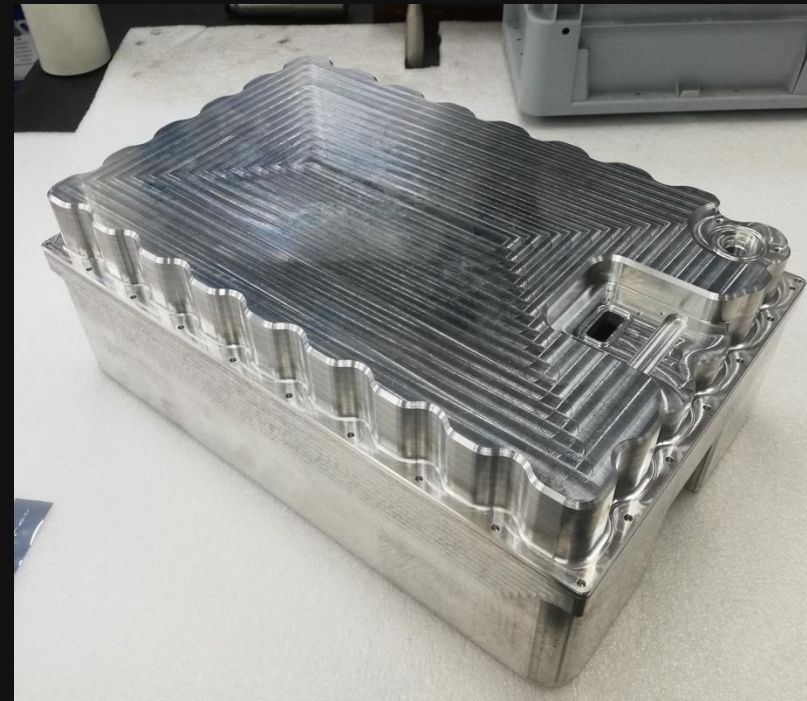
H O S P I T A L T O H O M E V I A S P A C E

THIS IS NOT SCI-FI
THIS IS NOW

BIOORBIT COMPLETED OUR FIRST IN ORBIT-DEMO



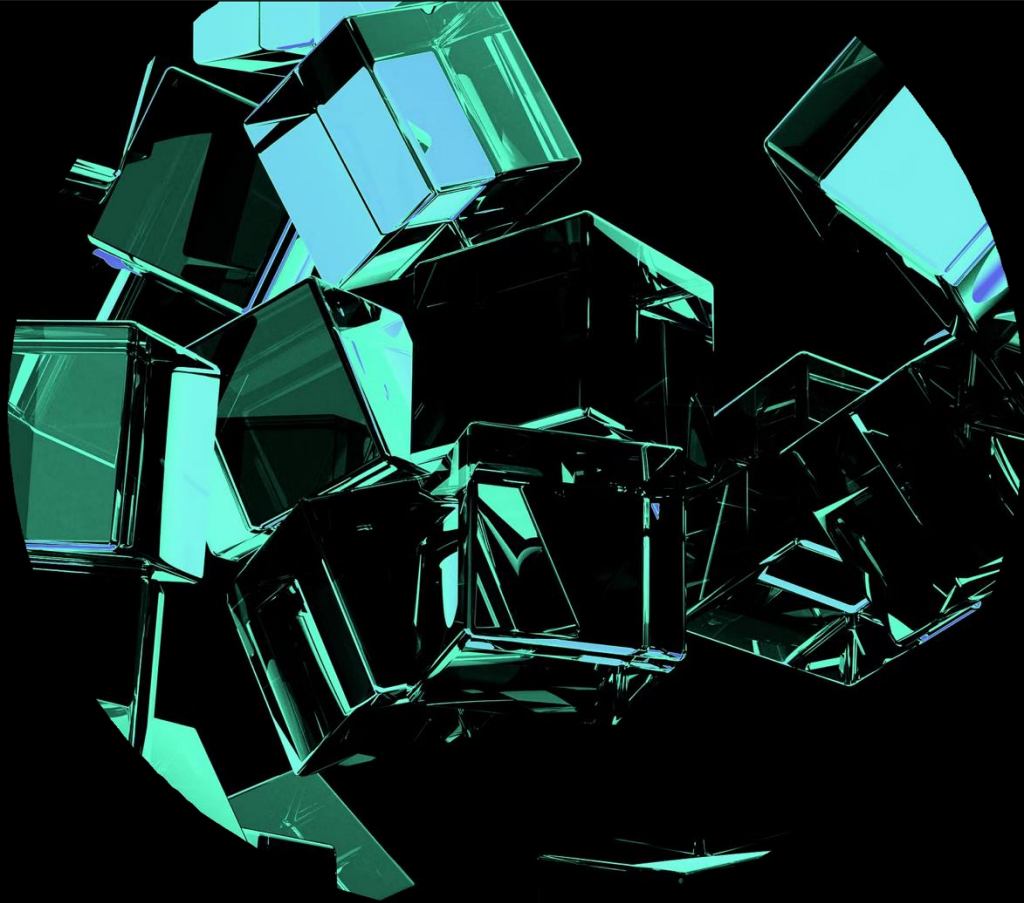
BABY BOX-E
ISS 2026 – SPACEX-CRS-34



BOX-E
ISS & VAST, 2027

Currently open for partners with target molecules for testing

Contact us for more information



BioOrbit

molly@bioorbit.com

H O S P I T A L T O H O M E V I A S P A C E

